

# INFLATION AND GROWTH IN SOUTH AFRICA

**D Hodge**

This paper studies the relationship between inflation and growth in South Africa. Two main issues are addressed: do tests of the South African data support the findings of cross-section studies that inflation has a negative effect on growth over the longer term; and can higher growth be gained at the cost of higher inflation in the short run? The findings are that inflation drags down growth in South Africa over the longer term; and that in the short run, growth above its trend requires accelerating inflation. Thus for growth to be pulled substantially above its present low trend, inflation targeting in South Africa would have to be abandoned. However, this would be counterproductive over the longer term once the negative relationship between inflation and growth manifests itself.

Key words: Inflation, Growth, South Africa, Long run versus short run, Trade-Off

JEL classifications: E31, E32, E61, O40, O55

## **1. Introduction**

Many recent studies, especially by researchers at the International Monetary Fund, show that there is a negative relationship between inflation and economic growth in the medium to long run (Barro 1991, 1995; Fischer 1993; Ghosh & Phillips 1998; Hadjimichael & Ghura 1995; Khan & Senhadji 2000; Sarel 1996; Sbordone & Kuttner 1994). Although there is considerable debate about the level above which the negative association between inflation and growth emerges, the general finding of these studies is that countries that keep inflation low enjoy higher rates of growth than countries that

tolerate high inflation.

Explanations of the negative relationship between inflation and growth in the long run are based on the idea that low inflation increases economic efficiency. High inflation rates are believed to interfere with the price signalling mechanism, resulting in a misallocation of resources in market economies. Also, real resources are consumed in seeking protection or to gain advantage from high inflation thereby diverting such resources from their optimal use. Moreover, low inflation enhances the functions of money as a medium of exchange, store of value and unit of account, adding further to economic efficiency. The latter has led some economists to argue that the optimum rate of inflation is less than zero (permitting a zero nominal interest rate and thus a real interest rate at the rate of deflation - see Sinclair 2003).

However, most studies recognize that a low but positive inflation rate may help the economy adjust to real shocks if nominal wages and other prices show downward rigidity - a certain amount of inflation may help to >grease the wheels= of the economy (Akerlof *et al.* 1996, 2000). Moreover, both theory and some empirical evidence suggest that, in the short run, growth may have to be sacrificed to get inflation down and keep it there. The latter is based on the Keynesian idea of a Phillips curve trade-off: unemployment can be lowered by discretionary monetary and fiscal policies that accommodate a higher inflation rate and vice versa. If the responsiveness of employment to economic growth remains positive (that is, there is no jobless growth), then the negative Phillips curve relationship between (wage) inflation and unemployment (Phillips 1958) implies a corresponding positive trade-off between inflation and growth.

A sustainable reduction in South Africa=s inflation rate is an important part of the government=s economic strategy. To achieve this objective, an inflation targeting framework for monetary policy was formally announced by the authorities in 2000 with

the first target to be met from 2002. The supposed longer-term growth benefits of low inflation is presumably one of the reasons why the authorities in South Africa decided on a relatively low inflation target of between 3 and 6 percent per annum. This was an ambitious target given the history of inflation in South Africa. Since 1970 a five-year moving average of the annual consumer price inflation rate has never fallen below 6 percent, notwithstanding ritual exhortations by successive Ministers of Finance and Governors of the Reserve Bank to fight inflation. Even when words were backed by tougher monetary and fiscal policies, it proved difficult to sustain single digit inflation rates in South Africa over the longer term. For example, inflation remained stubbornly high for most of the 1990s, averaging above 9 percent per annum despite the tough monetary policies and high real interest rates under the previous Governor, Dr Chris Stals.

Although the average headline inflation rate was below 6 percent per annum from 1999 until 2001, it then increased sharply following the rapid depreciation of the rand towards the end of 2001. The CPIX inflation rate targeted by the Reserve Bank (the monthly percentage change in the consumer price index excluding the interest cost of home loans, compared to the same month of the previous year) fell below the 6 percent upper limit for the first time only in September 2003. Real interest rates (prime overdraft rate minus the CPIX inflation rate) averaged an historically high 7,2 percent per annum over this period.

Two main concerns arise from the choice of inflation target in South Africa. First, is the negative inflation-growth relationship detected by the IMF research and in other studies also present in the South African data? Critics argue that the government's preoccupation with controlling inflation has contributed to the large increases in unemployment and pedestrian growth experience of the 1990s (see, for example, Michie

& Padayachee 1998; Moll 1993; Pillay 1997; Weeks 1999). They argue that there is no compelling reason to believe that moderately higher inflation rates in South Africa would harm the economy. They assert that growth would be higher and unemployment less under policies tolerating moderately higher inflation rates. Supporting such arguments are some of the IMF and other studies which show that, although low inflation is accompanied by higher growth in the medium to long run, the relationship is nonlinear: below a certain threshold the relationship is positive. Below this threshold, higher inflation is accompanied by higher rather than lower growth rates (Fischer 1993; Ghosh & Phillips 1998; Khan & Senhadji 2000; Sarel 1996). Some studies estimate the inflation threshold to be higher in developing than developed countries (Khan & Senhadji 2000). If such a threshold exists in South Africa and the present inflation target is below it, then on average monetary policy must be kept tighter and growth lower than necessary.

Second, even if lower inflation is accompanied by higher growth over the longer term, it would be useful to know what sort of growth sacrifice might be necessary in the short run to get within the present target range and stay there. If the evidence shows only an insignificant trade-off between inflation and growth, then the Minister of Finance can sleep peacefully. However, if the evidence suggests that a large chunk of growth must be foregone to achieve the inflation target, then the Minister's sleep may be less than serene. Opponents of the present inflation target could argue that the authorities should adopt more expansionary monetary and fiscal policies to boost growth and employment now, rather than bet on the less tangible benefits of higher growth deferred many years hence.

These concerns are addressed as follows. Section 2 examines the medium- to long-run relationship between inflation and growth in South Africa while Section 3 examines the short run. The main focus is on the basic direction and strength of the relationship between inflation and growth in each case, rather than on an attempt to model the more

complex interactions between the variables. Section 4 concludes. The main conclusion is that there is a strong negative relationship between inflation and growth over the longer term in South Africa. Inflation appears to have had a significant drag effect on growth over the sample period studied (1950 - 2002). This tallies with the findings of the broader panel regression studies referred to above. In the short run, there is mixed evidence establishing a positive relationship between inflation and growth for the sample period 1970 - 2003. Higher growth is associated with a higher inflation rate in the short run when growth is below its Hodrick-Prescott trend. But when growth rises above its trend, such a trade-off requires continual *accelerations* in the inflation rate. Thus in the short run, if the authorities want to use expansionary monetary and fiscal policies to pull growth substantially above the present low trend growth rate in South Africa, the current inflation target would have to be raised and soon abandoned altogether. However, there is little point in doing so, given the harm this may do to growth in the longer term.

## **2. Inflation and growth: the medium to long run**

The main difficulty in estimating the long-run relationship between inflation and growth for a single country like South Africa is the relatively small size of the sample observations. The studies referred to in the introduction invariably use panel regressions containing time series data on a large number of countries. For example, the study by Ghosh and Phillips (1998) included 145 countries for the period 1960 - 1996, comprising 3 603 base model observations. Thus the explanatory power of the regressions is increased by simultaneously testing across the time series and the between country dimensions. In a single country study, the between country comparisons necessarily fall away. Moreover to reduce the volatility of changes in the variables over the business cycle, the time series data are usually smoothed by taking averages of the annual data. If

we take consecutive five-year averages for a single country for the period 1950 - 2002 we have only ten observations to play with.

One way around this difficulty is to use moving averages. If we use a five-year moving average we lose only four observations from the annual time series data and we can get some idea of how growth is affected (if at all) as we gradually move from an environment of low to high inflation and vice versa. The association between inflation and growth in South Africa using this method for the period 1950 - 2002 is illustrated in Figure 1 below:

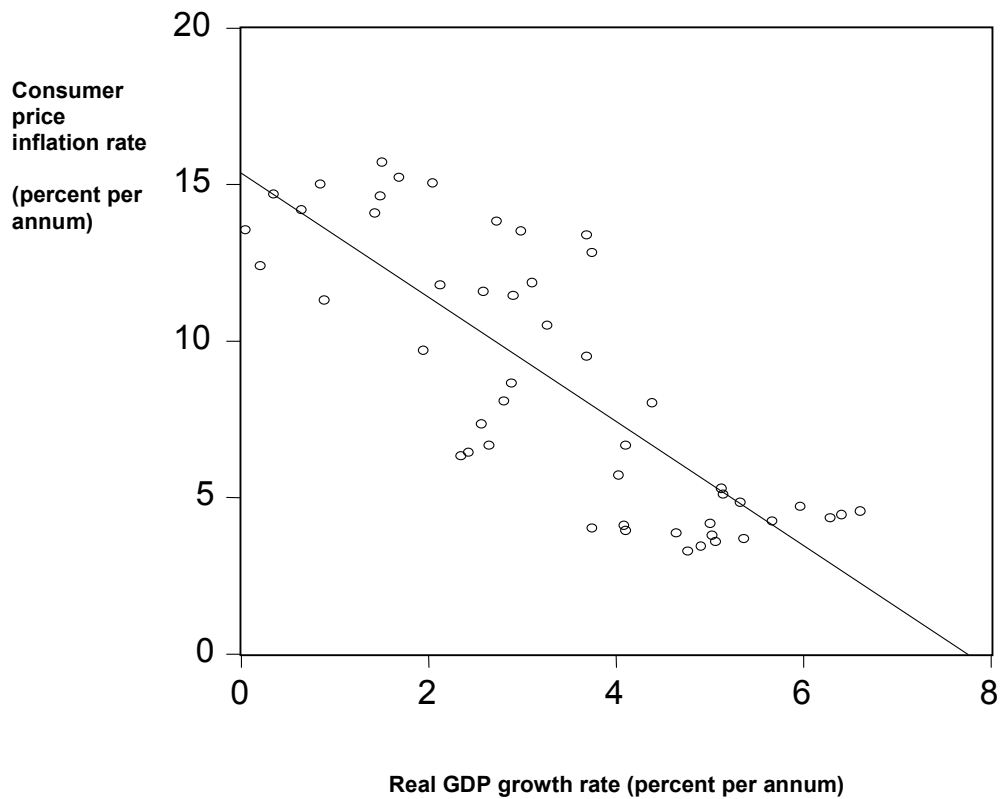


Figure 1: The relationship between inflation and growth in South Africa, 1950 – 2002.

A strong negative relationship between inflation and growth is suggested in Figure 1.

Another way of viewing this relationship is to note that for the given sample period, the average of the ten best years of growth in South Africa of 6,5 percent per annum was associated with an average inflation rate of only 5,9 percent per annum, while the averages for the ten worst years of growth were -0,5 percent and 13,4 percent respectively. Since 1950 the highest annual growth rates in South Africa have been associated with low inflation rates within the present inflation target.

Given the relatively small number of sample observations, no significant signs of any nonlinear relationship between inflation and growth are detectable in the data for South Africa. Regarding the possible existence of a low inflation threshold below which the relationship could turn positive, the five-year moving average of the inflation rate in South Africa has never fallen below 3 percent per annum. Figure 1 shows that between 3 and 6 percent, the relationship between inflation and growth is almost horizontal. So nothing can be said about the existence of such a threshold on the basis of the limited data. It is thus not possible to say whether the present inflation target is above or below any such threshold.

Similarly there is no evidence of any nonlinear relationship at the other extreme of high inflation rates. Some researchers have noted that the negative effect of inflation on growth weakens above a certain ceiling (Bruno & Easterly 1998; Fischer 1993; Ghosh & Phillips 1998). The highest five-year moving average observation of inflation in South Africa is only about 16 percent per annum. Thus the question whether much higher inflation rates would be accompanied by a proportionately smaller decline in growth in South Africa than inflation below such a ceiling must remain unanswered. For some South American countries like Brazil and Argentina, which have had significant periods of hyper-inflation, such a nonlinear relationship might be detectable.

To consider the above, a standard OLS linear regression equation was used to

model the relationship between inflation and growth in South Africa. A bivariate regression of the five-year moving averages of inflation on growth yields an estimate of the coefficient on the inflation rate of -0.33 which is significant at the one percent level, and an adjusted R-squared of 0.65. However, the low value of the Durbin-Watson statistic suggests that a bivariate regression may be mis-specified. This suspicion is confirmed by adding a simple time trend to the equation, which cuts the size of the inflation coefficient significantly while increasing the correlation coefficient. Other factors besides the inflation rate should be included in a better specified multivariate regression equation.

Mainstream economic theory is largely silent on the fundamental determinants of growth, other than physical investment and capital formation and, more recently, investment in human capital. Besides the inflation rate, four other plausible long-run determinants of growth in South Africa were selected: labour productivity (output per employee in manufacturing); gross fixed investment (as a proportion of gross domestic product); the tax burden (taxes on income and wealth as a proportion of GDP); and the terms of trade. Most of the time series data are from the *SARB Quarterly Bulletin*, except for labour productivity which was constructed from the manufacturing output and employment series in the *IMF Financial Yearbook*. The terms of trade data for the period 1950 to 1959 were derived from information provided by Statistics South Africa (from 1960 the data are published in the *SARB Quarterly Bulletin*).

Before we run the various econometric >experiments= the theoretically expected signs on the coefficients need some explanation. One would expect sustained increases in productivity to have a positive effect on growth over the longer term. Similarly, sustained increases in gross fixed investment (as a proportion of GDP) are expected to lead to higher growth rates over time. Supply side theory identifies an increasing tax burden as a

drag on growth, particularly taxes on income and wealth as opposed to taxes on consumption. This is because the former reduce the rewards for effort and risk taking and divert resources into avoidance activities more than the latter. Sustained improvements in the terms of trade are expected to enhance growth (and vice versa) especially for a commodity exporting country like South Africa, which has a relatively open economy and is heavily dependent on international trade. The basic equation to be tested is thus:

$$y_t = c + \nu p_t + w l_t + x K_t + s R_t + z t_t + e_t \dots\dots\dots(1)$$

where  $y_t$  is the annual percentage change in real gross domestic product,  $p_t$  is the annual percentage change in the consumer price index (for metropolitan areas),  $l_t$  is the annual percentage change in labour productivity in manufacturing,  $K_t$  is gross fixed investment as a proportion of GDP,  $R_t$  is the tax burden expressed as taxes on income and wealth as a proportion of GDP,  $t_t$  is the annual percentage change in the terms of trade (the export price index divided by the import price index), and  $c$  and  $e_t$  are the constant and error terms respectively. In the base model estimations, all variables are expressed as five-year moving averages. The hypothesized signs of the coefficients (italicised) on the variables are  $-p$ ,  $+l$ ,  $+K$ ,  $-R$  and  $+t$ , as explained above. In equation (1), growth is regarded as the dependent variable and the other factors as the independent variables. This is in contrast to the short-run relationship between inflation and growth estimated in Section 3, where the inflation rate is regarded as the dependent variable and the growth rate as one of the independent variables.

The OLS regression results for the base model are presented in section (i) of Table 1 below. All the coefficients are correctly signed and are significant at the ten percent level or better. Given the initial low value of the Durbin-Watson statistic, indicating high levels of serial correlation, the Cochrane-Orcutt procedure was used to randomize the error

terms. Due to the reliance on moving averages, both first and second order autoregressions were necessary to improve the Durbin-Watson statistic sufficiently.

In this exercise, changes in the inflation rate show a strong negative association with the growth rate in South Africa. The estimate of the coefficient on the inflation variable suggests that roughly a quarter of the variation in the growth rate can be explained by this variable alone. Over a five-year period, an increase in the average annual inflation rate of one percentage point is estimated to drag down the average annual growth rate by 0.26 of a percentage point.

insert Table 1 here (see attached)

Although not the focus of this study, the estimates of the other coefficients may also be commented on briefly. The results suggest that the tax burden contributes substantially to the explained variation in the growth rate. Since 1950 an increasing tax burden has gone hand in hand with a declining growth rate in South Africa. As regards changes in South Africa=s terms of trade, sustained improvements therein show the expected increase in average growth (and vice versa) but the explanatory power of this variable is low. This is probably because, even when smoothed by a five-year moving average, the volatile changes in South Africa=s terms of trade are much larger than the similarly smoothed changes in the growth rate.

The relatively low value of the coefficient on the investment term is surprising. However, collinearity between gross fixed investment and productivity is likely with increases in gross fixed investment contributing to increases in labour productivity. It is thus permissible to combine these two variables as an explanation of changes in the growth rate over time. It is important to note that productivity and investment, as well as the tax burden and terms of trade, are included mainly as >conditioning= variables to help avoid a misplaced emphasis on the inflation rate in a bivariate equation. Thus the presence of multicollinearity between these variables is not a serious concern here since

the main focus is on inflation and growth.

However, the presence of collinearity between the inflation rate, productivity and the tax burden underscores the point that the observed association between inflation and growth is not necessarily a causal relationship. Thus it can be argued that declining productivity led to both lower growth and higher inflation over the sample period and that the observed negative relationship between inflation and growth is merely coincidental. Still, the measured collinearity between inflation and productivity is weak - less than 15 percent of the variation in the inflation rate can be explained by productivity changes. Moreover, removing the inflation term from equation (1) substantially lowers the adjusted R-squared. This suggests that inflation has exerted an independent influence on growth in South Africa over the sample period. It should also be kept in mind that rising inflation may have led to the observed decline in productivity, and not vice versa. Regarding the observed collinearity between inflation and the tax burden it is more plausible that causation runs from the former to the latter rather than the reverse since, under a progressive tax structure, higher inflation leads to fiscal drag and proportionately higher taxes on income and wealth.

A possible objection to the results above, specifically the negative sign on the inflation coefficient, is that they are a statistical artifact of the five-year moving averages used to smooth the data. However, as is evident in section (ii) of Table 1, if we run the regression on the unadjusted annual data the size of the inflation coefficient changes only slightly and its sign remains significantly negative. The main casualties of the much greater noise present in the unadjusted annual data are that the investment term is no longer significant and the R-squared values are substantially lower. A similar pattern emerges when the regression is run using the two-, three-, and four-year moving averages of the data, where the inflation coefficient is estimated at -0.21, -0.29, and -0.22

respectively (for brevity not shown in Table 1). The less the data are smoothed, the lower are the R-squared values and the less significant are the estimates of the other conditioning variables. However, despite the much greater volatility of the variables, using such data does not materially change the negative inflation-growth relationship suggested by the base model estimates.

Another possible objection is that the results are biased by the different inflation-growth experiences before and after the mid-1970s. During the 1950s and 1960s, before the mounting inefficiencies and costs of the government's apartheid policies became manifest, such policies may have boosted growth and kept inflation at bay, at the expense of black workers and the suppression of trade union activity - a factor that was no longer a consideration by the 1990s. Also, like many other countries, stagflation became a problem in South Africa following the oil price hikes in the 1970s. Together with the rising costs of apartheid, this may have contributed to the lower growth and higher inflation experienced in the 1980s and the 1990s. Thus the low growth-high inflation experience of this period may give a negative bias to the inflation coefficient.

These and possibly other factors are reflected in a clear structural break in the growth-inflation relationship in South Africa in the mid-1970s: the sample data show that the average growth rate is significantly lower and the inflation rate higher after 1975 than before. For various reasons, since the mid-1970s stagflation in South Africa persisted for much longer compared to countries like the USA, UK, Germany and Japan (and more comparable countries such as Australia, Malaysia and Canada).

To allow for the possibility that the negative sign on the inflation rate is primarily due to the experience after the mid-1970s, the inflation sample data were split into two groups: a five-year moving average from 1954 - 1974 ( $p_1$ ) and from 1975 - 2002 ( $p_2$ ) respectively. If the coefficients have different signs or differ significantly in size, then the

robustness of the results for the sample period as a whole may be questioned. The results of this modification are shown in section (iii) of Table 1 (the estimates of the coefficients on the variables other than the inflation rate are virtually identical to the estimates in section (i) and are thus omitted here). The sign on  $p_1$  remains negative and only differs in size from the coefficient on  $p_2$  by 0.06 of a percentage point. Although the  $p_2$  data reinforce the negative growth-inflation relationship in South Africa, a similar relationship is clearly evident in the  $p_1$  data as well.

The evidence presented above suggests that the medium- to long-run relationship between inflation and growth in South Africa is strongly negative. The choice of a low inflation target thus appears to be a sensible one. As noted in the introduction, the highest growth rates in South Africa have been associated historically with inflation rates within the present 3 - 6 percent target range. However, a more precise indication of where the inflation target should be cannot be given using the limited sample data available for a single country like South Africa. Even with large sample multi-country panel regressions, researchers have produced varying estimates of the inflation threshold. Sarel's (1996) point estimate was 8 percent. Using a larger sample, Ghosh and Phillips's (1998) estimate was 2.5 percent. Bruno and Easterly (1998) only found evidence of a negative effect of inflation on growth above a threshold of 40 percent. For transition economies, Christoffersen and Doyle's (1998) estimate was 13 percent. Research by Khan and Senhadji (2000) suggests that the threshold is lower for developed countries than it is for developing countries. For developed countries they estimate the inflation threshold at 1 - 3 percent and for developing countries at 7 - 11 percent. South African data were included in the sample of developing countries. But without any convincing evidence of a threshold effect in the South African data, there is no clear indication in this study that the present inflation target of 3 - 6 percent should be raised to coincide with the 7 - 11

percent threshold for developing countries estimated by Khan and Senhadji.

The question then remains how much growth might have to be sacrificed in the short run to get inflation down within this range and to keep it there. Notwithstanding the longer-term results, is there any evidence of a trade-off between inflation and growth in South Africa in the short run?

### **3. Inflation and growth: the short run**

To examine the short-run relationship between inflation and growth, an approach different from that used in the analysis of the medium- to long-run relationship in Section 2 is necessary. There the focus was on the supply-side factors thought to influence growth over an extended period. In the short run, the focus shifts to the role played by changes in aggregate demand and to whether or not higher growth can be purchased at the cost of a higher inflation rate. The rationale for such a trade-off is based on a Keynesian-neoclassical aggregate demand and supply model. The long-run aggregate supply curve is vertical at a full employment level of output commensurate with the non-accelerating inflation rate level of unemployment or NAIRU. But a short-run supply curve exists along which output varies temporarily with changes in aggregate demand, in the same direction as the price level. This implies a positively sloped inflation-growth relationship. If the growth is not jobless, it also implies a negative Phillips curve relationship between inflation and unemployment.

Research on the existence of a Phillips curve trade-off between inflation and unemployment has produced mixed results. Studies of the relationship in the main industrialised countries including data from the 1950s until the mid-1970s suggested that such a trade-off was indeed present. However, the Phillips curve was pronounced dead by later studies in which sample data were dominated by the stagflation experience of the

1970s and early 1980s. It was subsequently resurrected - at least as regards the experience in the United States (see Brayton *et al.* 1999; Fuhrer 1995; Stiglitz 1997; Tootell 1994) and possibly in Europe as well. In South Africa, a trade-off between inflation and unemployment appeared to be present until the early 1970s but there is little evidence of a stable Phillips curve thereafter (see Gallaway *et al.* 1970; Truu 1975; Hodge 2002). This is because unemployment in South Africa has been determined largely by structural changes in the economy, rather than factors influencing aggregate demand - hence the jobless growth experienced in the 1990s. However, the question whether or not there is a positive short-run relationship between inflation and *growth* in South Africa is unresolved.

The approach used here to answer this question is based on the triangle model of inflation (Gordon 1994, 1997). In this model, the inflation rate is the dependent variable (unlike the longer-term analysis in Section 2 where it is one of the independent variables believed to influence growth) and there are three sets of independent variables on the right hand side of the equation: inertia, demand factors, and supply shocks. The inertia term recognizes that the current inflation rate is largely determined by its own history, represented by the lagged inflation rate. It is connected to adaptive expectations in that the inflation lag structure determines the expected inflation rate which in turn determines current wage and price inflation. The demand term may be represented by unemployment, employment, or growth variables depending on the aims of the test.

If the trade-off hypothesis is correct, then in the short run higher growth should be associated with higher inflation and vice versa. The supply-side variables depend on the structure and characteristics of the economy concerned. In South Africa, the most important supply shocks include changes in unit labour costs and import prices. Unit labour costs capture the net effect of changes in productivity and wages (and are thus a

measure of changes in the real cost of labour to employers). Import prices (as measured by a weighted import price index) capture the net effect of both changes in the exchange rate of the rand and exogenous price shocks such as the oil price hikes of the 1970s. The short-run inflation-growth relationship in South Africa may thus be written:

$$p_t = c + hp_{t-n} + iy_{t-n} + ju_{t-n} + km_{t-n} + e_t \dots\dots\dots(2)$$

where  $p_t$  is the contemporaneous inflation rate (the percentage change in the consumer price index for metropolitan areas),  $p_{t-n}$  is the lagged inflation rate,  $y_{t-n}$  is the lagged growth rate of real gross domestic product,  $u_{t-n}$  is the lagged change in the unit labour cost index,  $m_{t-n}$  is the lagged change in the import price index, and  $c$  and  $e_t$  are the intercept and error term respectively. All changes are unadjusted quarter-on-quarter percentage changes in the variables concerned. Quarterly data on all variables for the period 1970 - 2003 were taken from the *SARB Quarterly Bulletin*. The hypothesized signs on all the coefficients are positive.

A general-to-specific approach was used to determine the lag structure. Starting with a four-quarters lag on the inflation rate and a contemporaneous and four-quarters lag on the other variables, insignificant estimates were pared off until the best fit structure was obtained. All the time series data were first tested for unit roots. Augmented Dickey-Fuller (ADF) tests rejected the presence of a unit root in all cases (for both intercept and trend and at various lags) at the five percent level of significance or better. Thus all the series were found to be  $I(0)$ , that is, stationary in level form (the quarterly percentage changes thus have a similar effect to taking first differences of the index numbers in each case). These results justify greater confidence that any significant regression estimates reveal a structural relationship and are not the spurious result of coincidental trends in the

time series data.

ARCH LM tests were used in addition to the Durbin-Watson tests to check the significance of serial correlation of the residuals. The Durbin-Watson statistic can be a misleading measure of serial correlation when lags of the dependent variable (the inflation rate) are included as an explanatory variable in the model. However, none of the LM test F-statistics reported in Table 2 below was found to be significant at either the first (1) or second (2) lag at less than the ten percent level of probability (the lowest probability for any of the F-statistics reported in Table 2 was 0.19).

Pairwise Granger causality tests were run on the inflation rate and the growth rate, the change in unit labour costs, and the change in the import price index respectively. This is to check whether or not the short-run model is specified correctly in making the inflation rate the dependent variable. Granger causality is based on the idea that prior changes in variable X produce contemporaneous changes in variable Y. As regards the main relationship between inflation and growth, the null hypothesis that growth does not Granger cause the inflation rate can be rejected up to the third lag. Reverse causation is also possible, given that an inflation index is used to deflate nominal GDP. However, the null hypothesis that the inflation rate does not Granger cause the growth rate cannot be rejected up to the tenth lag (see also the discussion below regarding the contemporaneous association between inflation and growth).

Dual causality occurs when prior changes in X are associated with changes in Y *and* prior changes in Y are associated with changes in X. This is the case here as regards the relationship between the inflation rate and changes in unit labour costs. Up to the second lag, the null hypothesis that changes in unit labour costs do not Granger cause the inflation rate can be rejected. But up to the fifth lag, the null hypothesis that the inflation rate does not cause changes in unit labour costs cannot be rejected either. Thus dual

causality is present, with prior changes in unit labour costs determining the contemporaneous inflation rate and vice versa. This is generally the case with adaptive expectations: prior experience of inflation determines current wage setting behaviour (and thus unit labour costs) which in turn has a lagged effect on the inflation rate.

The null hypothesis that changes in the import price index do not Granger cause the inflation rate cannot be rejected up to the tenth lag. This is because changes in import prices affect the inflation rate very quickly and thus cannot be detected by the Granger causality test, which uses lagged values of the quarterly data. The lagged effect of import prices on the inflation rate can only be detected using monthly data. As can be seen in Table 2, the contemporaneous quarterly change in the import price index is a significant determinant of the inflation rate in all the estimations of the model.

The regression results for the base model are presented in section (i) of Table 2 below. As expected, the inertia term represented by the lagged inflation rate accounts for most of the explained variation in the contemporaneous inflation rate. The estimates for changes in unit labour costs and import prices suggest that these cost or supply shocks are transmitted relatively quickly to the contemporaneous inflation rate. The strong positive link between inflation, unit labour costs and import prices is found in all the modifications of the base model set out in Table 2. These results concur with those of Akinboade and Niedermeier (2002) who specify a structural VAR model of South Africa's inflation rate. Using a cointegration approach, they show that shocks to real wages and depreciation in the nominal effective value of the rand determine the inflation rate in the short run.

In the inflation-growth relationship, if the trade-off hypothesis is correct then the sum of the significant coefficients on the contemporaneous and lagged growth terms should be positive. Although the coefficient on the first lag of the growth rate [  $y(-1)$  ] is

positive, this is outweighed by the negative coefficients on the contemporaneous and third quarter lag [  $y$  and  $y(-3)$  ]. Thus if the short run is defined as a year, an increase in growth over this period is on average associated with a decline in the inflation rate. This is the opposite of what one would expect if the trade-off hypothesis is correct. The relatively low adjusted R-squared indicates the weaker explanatory power of the model (compared to the medium- to long-run model in Section 2). This is to be expected given the much greater noise present in the more volatile quarterly changes in the variables concerned. About half of the short run variation in the inflation rate remains unexplained by the model.

The negative sign on the contemporaneous growth term is worth discussing briefly. The main reason is probably that an inflation index, the GDP deflator, is used to deflate nominal GDP to derive real GDP. Thus any increase in the inflation rate resulting from a cost or supply shock in a particular quarter will tend to drag down the growth rate in that quarter. This negative effect may dominate any positive association between inflation and growth arising from increases in aggregate demand. Cost or supply shocks are likely to be transmitted to the inflation rate more quickly than the effect of changes in aggregate demand. The Granger causality test referred to earlier cannot detect the contemporaneous effect of inflation on growth, as such tests rely on the lagged effect of one variable on another. Since the model includes both contemporaneous and lagged growth terms, any positive association between inflation and the lagged growth terms must be strong enough to offset the negative effect of inflation on the contemporaneous growth rate. If not, then the trade-off hypothesis must be rejected for the short-run period as a whole.

insert Table 2 here (see attached)

To give the trade-off hypothesis a better chance of acceptance, the base model was modified by separating the growth data into two groups: the upswings (yUP) and downswings (yDOWN) of the South African business cycle respectively. The business cycle periods in South Africa are published in the *SARB Quarterly Bulletin*. If prices are sticky downwards, then evidence of a positive relationship between inflation and growth might be obscured by the preponderance of stagflation during the downswings. Episodes of stagflation would impart a negative bias to the growth coefficient for the sample as a whole. Thus the sign on yUP should be significantly greater than that on yDOWN if the trade-off hypothesis is correct. The results of the estimates of the modified model are presented in section (ii) of Table 2. The signs on both the contemporaneous and fourth lag of yDOWN are indeed significantly negative, capturing the strong effect of stagflation on the relationship. Although the sign on the first lag of yUP is positive, it is more than offset by the negative value on the third lag thereof. So even when the negative bias of the downswing periods is isolated from the sample, there is still little evidence of a trade-off between inflation and growth in South Africa.

The above two tests provide mixed evidence of a short-run trade-off between inflation and growth in South Africa. On balance, the evidence at this point suggests a negative coefficient on growth instead of the hypothesized positive relationship. However, the model might be mis-specified in that the true relationship may well be between growth and *changes in the inflation rate* rather than the inflation rate as such. In the Friedman (1968, 1977) and Phelps (1967, 1970) critique of the Phillips curve, unemployment can only be held below the NAIRU at the cost of an *accelerating* inflation rate. This implies that a growth rate higher than that commensurate with the NAIRU can also only be achieved by expanding aggregate demand at an increasing rate and allowing inflation to accelerate. Accordingly, a positive relationship should be more readily

detectable between the growth rate and the *change* in the inflation rate from one quarter to the next.

To test this hypothesis, the base model was modified in two ways: by using trend growth as a proxy for the potential growth rate corresponding with the time-varying NAIRU; and by taking first differences of the inflation rate (and of all the independent variables except the growth rate) as a measure of the change in the inflation rate,  $\Delta p$ . Actual growth rates above or below the trend growth rate are thus a crude estimate of the output gap. A Hodrick-Prescott (1997) filter was used to derive the growth trend. The Hodrick-Prescott filter has been criticised on various grounds - for example, that the choice of smoothing parameter is somewhat arbitrary. However, there do not appear to be any clearly superior estimates of (or proxies for) the potential growth rate in South Africa (see du Toit & Moolman 2003). In studies of other countries a natural growth rate is sometimes estimated, defined as the growth rate consistent with no change in the percentage level of unemployment, as in Leon-Ledesma and Thirwall (2002). However, the unemployment data in South Africa are patchy and unreliable, with no consistent time-series data going back further than 1982. For the limited aims of the simple model presented here, the Hodrick-Prescott technique does not seem inappropriate.

Two cases can be distinguished in terms of the Friedman-Phelps interpretation of the Phillips curve and its implications for the inflation-growth relationship in South Africa. When the growth rate is below its Hodrick-Prescott trend (yBELOW), there should be a positive relationship between inflation and growth. Under these conditions, an increase in aggregate demand should allow higher growth to be purchased at the cost of a once-off increase in the inflation rate (a constant rate of increase in the price level). However, an implication of the Friedman-Phelps argument is that no such positive relationship should be observed when growth is above its trend (yABOVE). This requires

continual *accelerations* in aggregate demand and the inflation rate. Constant increases in demand resulting in a once-off increase in the inflation rate will not suffice to sustain growth above its trend. The results of these econometric experiments are presented in sections (iii) and (iv) of Table 2.

The results strongly corroborate the Friedman-Phelps argument when applied to the South African data. In section (iii) of Table 2, no significant short-run relationship between inflation and growth can be detected when growth is above its Hodrick-Prescott trend. However, the coefficient on  $y_{\text{BELOW}}(-1)$  establishes that there is a significant positive relationship between inflation and growth, when growth is *below* its trend. Under these conditions, a one percentage point increase in the quarter-on-quarter growth rate can be sustained at the cost of an increase in the inflation rate of 0.37 of a percentage point (with the increase in growth affecting the inflation rate after a one quarter lag). In section (iv) of Table 2 the positive coefficient on  $y_{\text{ABOVE}}(-1)$  shows that a trade-off is still possible when growth rises *above* its trend, but only at the cost of an *accelerating* inflation rate (by 0.36 of a percentage point per quarter).

The negative sign of the estimates on the lagged changes in the inflation rate is to be expected. The negative sign implies mean reversion of changes in the inflation rate. A positive sign would imply that increases in the inflation rate are followed by further increases thereof and thus an ever-accelerating inflation rate, which is not a feature of the inflation rate in South Africa for the sample period studied. Unit labour costs are less important in this modification of the model in explaining changes in the inflation rate, whereas import prices take on greater significance.

Given the most recent data available at the time of writing, from the end of the second quarter of 2002 to the end of the second quarter of 2003 the average annual growth rate in South Africa was only about 2 percent compared to the Hodrick-Prescott

trend of 2.5 percent. Under these conditions, moderately expansionary demand policies can be used to boost growth without any significant upward pressure on the inflation rate. However, barring any (favourable or unfavourable) shocks to import prices and unit labour costs, a sustained demand led increase in the growth rate substantially above its trend implies increases in the inflation rate that would soon breach the 6 percent per annum upper boundary of the current CPIX inflation target. The more ambitious the desired growth rate is, the more inflation would be likely to increase and the sooner this boundary would be breached.

This exercise is not intended as a forecast but simply to illustrate the parameters of the trade-off implied by the estimated short-run relationship between inflation and growth in South Africa. Although some relaxation of fiscal policy seems likely in 2004 and 2005, the consensus is that monetary policy will remain sufficiently tight to ensure that the current inflation target is met. Thus there does not appear to be any immediate prospect of aggregate demand rising sufficiently to sustain growth above, say, the 4 percent per annum mark for very long. But if it did, the accompanying rise in inflation could soon threaten the current inflation target. Thus the authorities would have to tighten monetary and possibly fiscal policies again if they are serious about sticking to the target.

This may seem to be a rather pessimistic outlook, given the present low trend growth rate. However, the pitfalls in using a mechanical statistical technique like the Hodrick-Prescott filter to estimate the potential growth rate must be kept in mind. For example, Leon-Ledesma and Thirwall (2002) provide evidence that increases in aggregate demand can pull up the potential growth rate in the sense of the demand for output creating its own supply. If longer-term growth in South Africa is partly endogenous in this sense and not fully determined by supply-side factors, then increased demand could also raise the trend growth rate, implying less of an output gap than suggested in the

example above (but inflation may have to rise above the inflation target first, before these benefits are realised). In this vein, Weeks (1999) argues that the Growth, Employment and Redistribution (GEAR) programme adopted by the new government in 1996 was overly restrictive and largely responsible for the disappointing growth performance of the South African economy in the 1990s. It remains to be seen whether the various longer-term structural reforms undertaken by the government will gradually bring about the desired increase in sustainable growth and employment that, until now, has been largely conspicuous by its absence.

To summarise, the test results suggest that evidence of a positive relationship between inflation and growth in the short run is sensitive to the precise specification of the model. No net positive relationship can be detected using unadjusted quarter-on-quarter inflation and growth rates, even when periods of stagflation are isolated by separating the downswings from the upswings of the South African business cycle. The trade-off between inflation and growth only becomes apparent when the model is modified to include a more sensitive indicator of excess demand pressure in the economy, such as deviations of growth above and below its Hodrick-Prescott trend. The test results suggest that any such trade-off is unsustainable as it depends on continual acceleration in the inflation rate once growth rises above its trend.

Boosting growth in this way means that inflation would soon breach the upper boundary of the current inflation target of 3 - 6 percent. Sustaining growth substantially above its trend thus implies raising the inflation target. However, the continual acceleration of the inflation rate necessary to keep growth above its trend means that the inflation target would soon need to be raised again. This would quickly destroy any credibility in the inflation targeting regime, which would consequently have to be abandoned. Moreover, at some point the negative medium- to long-term drag effect of

higher inflation on growth estimated in Section 2 would begin to emerge. Thus in South Africa the scope to gain higher growth at the cost of higher inflation appears to be very limited.

#### **4. Conclusion**

This study examined the relationship between inflation and growth in South Africa over both the medium to long term and the short run. Two base models were used to estimate these relationships, as well as some modifications of each to test the robustness thereof. The focus is on the direction and magnitude of the relationship in each case. No attempt was made to model the interactions between the variables beyond a linear OLS multivariate regression analysis. However, despite their limitations, these models reveal some useful insights into the inflation-growth relationship in South Africa.

The sample for the medium to long term model comprised annual observations of the growth rate and the inflation rate, including other variables believed to influence growth over the longer-term, for the period 1950 - 2002. The results suggest that South Africa conforms to the general finding of various large sample cross-section studies, that there is a significant negative relationship between inflation and growth over the medium to long term. In contrast to some of these studies, a simple linear relationship gives the best fit to the South African data. Possibly due to the relatively small number of sample observations, there is no clear evidence of any nonlinear relationship between inflation and growth in South Africa over the medium to long term. In particular, there is no clear indication of a low inflation threshold below which the relationship turns positive, that is, where higher inflation might benefit rather than harm growth.

The main finding is that over a five-year period, a one percentage point increase in the average annual inflation rate drags down the average annual growth rate in South

Africa by about a quarter of a percentage point. The negative relationship between inflation and growth is stronger after the mid-1970s than before. However, the results do not change materially after separating the inflation data into pre- and post-1975 observations. This was done to check for possible bias due to the protracted periods of stagflation experienced in South Africa after 1975. In each group, the coefficient on the inflation rate remains significantly negative. The drag effect of inflation on growth varies from about a fifth to a quarter on the pre- and post-1975 observations respectively.

Moreover, the negative inflation coefficient does not appear to be a statistical artifact of the moving average technique used to smooth the data. The unadjusted annual data show a similarly negative relationship between inflation and growth in South Africa, even though the more volatile annual data understandably lower the correlation coefficient substantially and the negative sign on the inflation coefficient is somewhat smaller.

The results also suggest that in the short run there is limited scope to promote higher growth at the cost of higher inflation. A simple triangle model of inflation was tested using quarterly data for the period 1970 - 2003. The base model includes the lagged inflation rate (inertia); the lagged growth rate (representing the net effect of demand factors at work in the economy); and lagged changes in unit labour costs and import prices (capturing the main supply shocks). To guard against a possible negative stagflation bias to the inflation-growth relationship, the base model was modified by separating the growth observations into the upswings and downswings of the South African business cycle respectively. The base model was also modified by replacing unadjusted quarterly growth with deviations in the growth rate from its Hodrick-Prescott trend and by taking the first difference change in the inflation rate as a measure of its rate of acceleration.

The estimates of the tests using the unadjusted growth data fail to show a significant positive relationship between inflation and growth in the short run, even when the negative stagflation bias to the relationship was isolated in the downswings of the business cycle. If anything the estimates suggest a negative relationship, contrary to the positive relationship implied by the trade-off hypothesis. However, stronger evidence of a trade-off was found using deviations of growth from its Hodrick-Prescott trend and when the inflation rate was replaced by *changes in the inflation rate*. When growth is below its trend, higher growth can be achieved at the cost of a once-off increase in the inflation rate. But once the actual growth rate rises above its trend, further increases in the growth rate in South Africa are accompanied by continued *accelerations* in the inflation rate. Thus if discretionary monetary and fiscal policies are used in an attempt to sustain a desired growth rate substantially above its trend, this implies raising the current inflation target and eventually abandoning inflation targeting in South Africa altogether. Moreover the medium- to long-term negative drag effect of higher inflation on growth would gradually begin to take hold, undoing any benefit to growth that such action might achieve in the short run.

Taken together, the main implication of the longer-term and short-run analysis here is that there is little point in trying to boost growth in South Africa by raising the current 3 - 6 percent inflation target. Not only is this likely to be counterproductive as regards the longer-term growth performance of the economy, but there appears to be limited scope for even a temporary growth dividend in this regard.

### **Bibliography**

Akinboade, O. A. and Neidermeier E. W. 2002. Labour costs and inflation in South Africa: an econometric study, *Journal for Studies in Economics and Econometrics*,

vol.26(2), 1 - 18.

Akerlof, G. A., Dickens, W and Perry G. 2000. Near-rational wage and price setting and the long run Phillips curve, *Brookings Papers on Economic Activity*, Vol.1, 1 - 60.

Akerlof, G. A., Dickens, W. and Perry, G.1996. The macroeconomics of low inflation, *Brookings Papers on Economic Activity*, vol.1, 1 - 59.

Barro, R. 1991. Economic growth in a cross-section of countries, *Quarterly Journal of Economics*, vol.106(2), 407 - 443.

Barro, R.1995. Inflation and economic growth, *Bank of England Quarterly Bulletin*, vol.35 (May), 166 - 176.

Brayton, F., Roberts, J. M. and Williams, J. C. 1999. What=s happened to the Phillips curve?, Federal Reserve Board, Division of Research and Statistics, September, 1 - 38.

Bruno, M. and Easterly, W. 1998. Inflation crises and long-run growth, *Journal of Monetary Economics*, vol.41 (February), 3 - 26.

Christoffersen, P. F. and Doyle P. 1998. From inflation to growth: eight years of transition, IMF Working Paper 98/99, Washington: International Monetary Fund.

du Toit, C. and Moolman E. 2003. Estimating potential output and capacity utilisation for the South African economy, *South African Journal of Economics*, vol.71 (1), March, 96 - 118.

Fischer, S. 1993. The role of macroeconomic factors in growth, *Journal of Monetary Economics*, vol.32 (December), 485 - 512.

Friedman, M. 1968. The role of monetary policy, *American Economic Review*, vol.58 (March), 1 - 17.

Friedman, M. 1977. Unemployment versus inflation?: an evaluation of the Phillips curve, IEA Occasional Paper 44, 1 - 36.

- Fuhrer, J. C. 1995. The Phillips curve is alive and well, *New England Economic Review*, March - April, 41 - 56.
- Gallaway, L. E., Koshal, R.K. and Chapin, G. L. 1970. The relationship between the rate of change in money wages and unemployment levels in South Africa, *South African Journal of Economics*, December, 367 - 373.
- Ghosh, A. and Phillips, S. 1998. Warning: inflation may be harmful to your growth, *Staff Papers*, International Monetary Fund, vol. 45(4), 672 - 710.
- Gordon, R. J. 1994. Inflation and unemployment: where is the NAIRU?, Paper presented to the Board of Governors of the Federal Reserve System, Meeting of Academic Consultants, December 1.
- Gordon, R. J. 1997. The time varying NAIRU and its implications for economic policy, *Journal of Economic Perspectives*, vol.11(1), Winter, 11 - 32.
- Hadjimichael, M. and Ghura, D. 1995. *Sub-Saharan Africa: Growth, Savings, and Investments 1986 - 93*. IMF Occasional Paper No.118, Washington: International Monetary Fund.
- Hodge, D. 2002. Inflation versus unemployment in South Africa: is there a trade-off?, *South African Journal of Economics*, vol.70(3), March, 417 - 443.
- Hodrick, R. J. and Prescott, E. C. 1997. Post-war U.S. business cycles: an empirical investigation, *Journal of Money, Credit, and Banking*, vol.29, 1 - 16.
- Khan, M. S. and Senhadji, A. S. 2000. Threshold effects in the relationship between inflation and growth, *IMF Working Paper*, no.110, 1 - 31.
- Leon-Ledesma, M. A. and Thirwall, A. P. 2002. The endogeneity of the natural rate of growth, *Cambridge Journal of Economics*, vol.26, 441 - 459.
- Michie, J. and Padayachee, V. 1998. Three years after apartheid: growth, employment and redistribution, *Cambridge Journal of Economics*, vol.22 (5), 624 - 636.

- Moll, T. 1993. Monetary policy since 1989: is the >Stalsjacket= working?, Mimeo, EBM Research Conference, Cape Town, 29 - 30 November.
- Phelps, E. S. 1967. Phillips curves, expectations of inflation and optimal unemployment over time, *Economica*, vol.34 (August), 254 - 281.
- Phelps, E. S. 1970. Money wage dynamics and labour market equilibrium, in Phelps, E. S. (ed.), *Microeconomic Foundations of Employment and Inflation Theory*, New York: Norton.
- Phillips, A. 1958. The relation between unemployment and the rate of change of money wage rates in the United Kingdom, 1861 - 1957, *Economica*, vol.25(November), 283 - 299.
- Pillay, V. 1997. South Africa=s monetary and foreign exchange rate policy, in Michie, J. and Padayachee, V. (eds.), *The Political Economy of South Africa=s Transition: Policy Perspectives in the Late 1990s*, London: Dryden Press, 101 - 124.
- Sarel, M. 1996. Nonlinear effects of inflation on economic growth, *Staff Papers*, International Monetary Fund, vol.43(March),199 - 215.
- Sbordone, A. and Kuttner, K. 1994. Does inflation reduce productivity?, *Economic Perspectives*, vol.18 (November - December), 2 - 14.
- Sinclair, P. 2003. What do we know about the optimum rate of inflation?, mimeo, seminar presentation at the South African Reserve Bank, Pretoria, 6 June, 1 - 18.
- Stiglitz, J. 1997. Reflections on the natural rate hypothesis, *Journal of Economic Perspectives*, vol.11(1), Winter, 3 - 10.
- Tootell, G. M. B. 1994. Restructuring, the NAIRU, and the Phillips curve, *New England Economic Review*, September - October, 31 - 44.
- Truu, M. L. 1975. Inflation in the South African economy, *South African Journal of Economics*, vol.43 (4), 446 - 470.

Weeks, J. 1999. Stuck in low GEAR? Macroeconomic policy in South Africa, 1996 - 98,

*Cambridge Journal of Economics*, vol.23, 795 - 812.



Table 1. Results and Test Statistics of OLS Regressions on the Medium- to Long-Term Inflation-Growth Relationship in South Africa

VARIABLE	COEFFICIENT	STD ERROR	t-STATISTIC
<b>Section i (base model)</b>			
1956 - 2002. N = 47			
p	-0.26	0.06	-4.33 <sup>a</sup>
l	0.17	0.07	2.39 <sup>b</sup>
K	0.09	0.05	1.67 <sup>c</sup>
R	-0.26	0.13	-1.98 <sup>b</sup>
t	0.09	0.04	2.68 <sup>a</sup>
Intercept	6.21	2.00	3.10 <sup>a</sup>
AR(1)	1.14	0.14	8.10 <sup>a</sup>
AR(2)	-0.53	0.15	-3.63 <sup>a</sup>
Adjusted R-squared	0.94		
Durbin-Watson	2.03		
-----			
<b>Section ii (unadjusted annual data)</b>			
1951 - 2002. N = 52			
p	-0.23	0.08	-2.78 <sup>a</sup>
l	0.19	0.07	2.82 <sup>a</sup>
K	0.06	0.08	0.74
R	-0.30	0.18	-1.70 <sup>c</sup>
t	0.06	0.03	2.00 <sup>b</sup>
Intercept	7.91	3.26	2.43 <sup>b</sup>
AR(1)	0.38	0.15	2.50 <sup>a</sup>
AR(2)	-0.25	0.15	-1.64 <sup>c</sup>
Adjusted R-squared	0.54		
Durbin-Watson	2.10		
-----			
<b>Section iii (inflation data separated by structural break)</b>			
1956 - 2002. N = 47			
p <sub>1</sub>	-0.19	0.09	-2.10 <sup>b</sup>
p <sub>2</sub>	-0.25	0.06	-4.06 <sup>a</sup>
Adjusted R-squared	0.94		
Durbin-Watson	2.08		
-----			

Superscript a, b, or c on the t-statistic means that the estimates are significant at the one, five, or ten percent level respectively.

*Table 2. Results and Test Statistics for OLS Regressions of the Short-Run Inflation-Growth Relationship in South Africa*

VARIABLE	COEFFICIENT	STD ERROR	t-STATISTIC
<b>Section i (base model)</b>			
1970:4 - 2003:1. N = 130			
p(-1)	0.36	0.08	4.68 <sup>a</sup>
p(-2)	0.17	0.08	2.23 <sup>b</sup>
y	-0.18	0.08	-2.43 <sup>b</sup>
y(-1)	0.23	0.08	3.03 <sup>a</sup>
y(-3)	-0.13	0.07	-1.79 <sup>c</sup>
u(-1)	0.11	0.04	3.20 <sup>a</sup>
m	0.17	0.03	5.94 <sup>a</sup>
Intercept	0.51	0.24	2.16 <sup>b</sup>
Adjusted R-squared	0.53		
Durbin-Watson	1.99		
LM, F-statistic	1.53 (1) ; 0.98 (2)		
<hr/>			
<b>Section ii (growth separated by business cycle phases)</b>			
1971:1 - 2002:4. N = 128			
p(-1)	0.38	0.07	5.20 <sup>a</sup>
yUP(-1)	0.19	0.09	2.04 <sup>b</sup>
yUP(-3)	-0.20	0.09	-2.22 <sup>b</sup>
yDOWN	-0.23	0.11	-2.06 <sup>b</sup>
yDOWN(-4)	-0.24	0.11	-2.15 <sup>b</sup>
u	0.06	0.03	1.68 <sup>c</sup>
u(-1)	0.12	0.03	3.79 <sup>a</sup>
m	0.16	0.03	5.89 <sup>a</sup>
Intercept	0.73	0.20	3.57 <sup>a</sup>

Adjusted R-squared 0.53  
 Durbin-Watson 2.08  
 LM, F-statistic 1.44 (1) ; 0.67 (2)

---

**Section iii (deviations of growth from HP trend; unadjusted inflation rate)**

1970:3 - 2002:4. N = 130

p(-1)	0.29	0.08	3.75 <sup>a</sup>
p(-2)	0.19	0.08	2.47 <sup>a</sup>
yBELOW(-1)	0.37	0.12	3.11 <sup>a</sup>
u	0.07	0.03	2.08 <sup>b</sup>
u(-1)	0.10	0.04	2.94 <sup>a</sup>
m	0.15	0.03	5.34 <sup>a</sup>
Intercept	0.62	0.21	2.98 <sup>a</sup>

Adjusted R-squared 0.51  
 Durbin-Watson 1.96  
 LM, F-statistic 0.64 (1) ; 0.79 (2)

---

**Section iv (deviations of growth from HP trend; change in the inflation rate)**

1971:2 - 2003:1. N = 128

✦p(-1)	-0.55	0.09	-6.38 <sup>a</sup>
✦p(-2)	-0.39	0.10	-4.00 <sup>a</sup>
✦p(-3)	-0.29	0.10	-3.00 <sup>a</sup>
✦p(-4)	-0.35	0.08	-4.16 <sup>a</sup>
yABOVE(-1)	0.36	0.15	2.44 <sup>b</sup>
✦u(-1)	0.05	0.02	2.15 <sup>b</sup>
✦m	0.17	0.03	5.39 <sup>a</sup>
✦m(-1)	0.14	0.04	3.87 <sup>a</sup>
✦m(-2)	0.13	0.04	3.26 <sup>a</sup>
✦m(-3)	0.11	0.04	3.18 <sup>a</sup>
✦m(-4)	0.11	0.03	3.21 <sup>a</sup>
Intercept	-0.10	0.09	-1.19 <sup>a</sup>

Adjusted R-squared 0.45  
 Durbin-Watson 1.93  
 LM, F-statistic 0.99 (1) ; 0.74 (2)

---

Superscript a, b, or c on the t-statistic means that the estimate is significant at the one, five, or ten percent level respectively

---

